A low energy two-stage technology for leachate valorisation

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CARTIF

Life

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LIFE leachless

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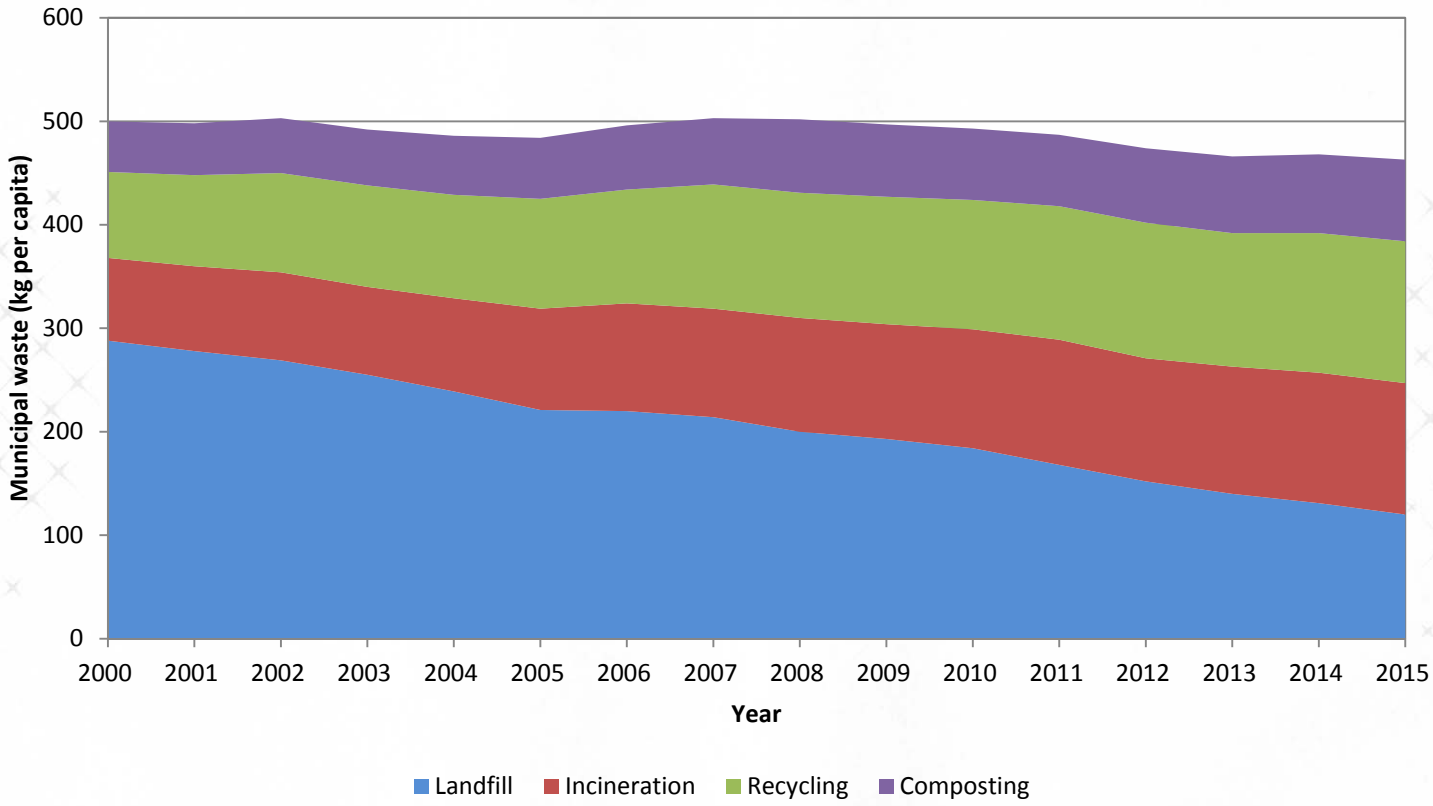
Background

- In the EU, annually 16 tonnes of materials are used by each person and 6 tonnes of it are converted into waste.
- Solid waste can be disposed in various ways:
  - Incineration.
  - Landfilling.
  - Recycling.
  - Composting.

- Landfilling has been the most commonly used solid waste disposal, especially in the Mediterranean and Eastern Europe countries.
- Landfills present long-term threats to soil, air, groundwater and surface water due formation of greenhouse gases (methane gas and carbon dioxide from decomposing garbage) and leachate.

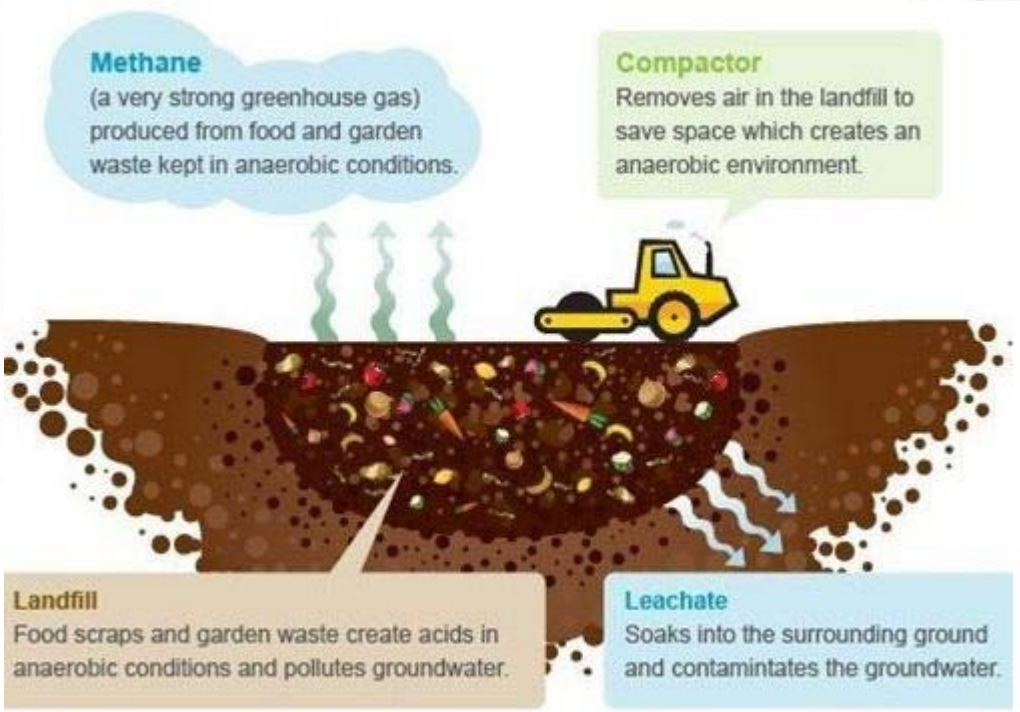
Background



Municipal waste generation and treatment, EU-27 (Source: Eurostat, 2017)

Leachate

- Leachate is the **liquid fraction** of the already existing moisture/liquid within the **solid waste** and the continuously formed liquid with dissolved and suspended solids extracted from the waste while rainfall percolates through it.
- Not only during their useful life, but also **fifty years after their closure**, landfills keep on producing leachate.
- Approximately, **10 m^3** of leachate is generated per **115 tonnes** of solid waste.
- The **composition** of leachate **differs** from site to site and also within the landfill, the composition of the leachate alters with time (from weeks to years).



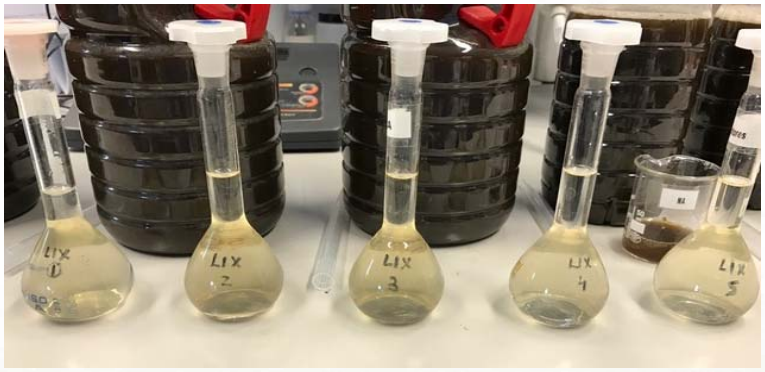
Leachate

- The **composition** of the leachate depends on **factors** such as characteristics of the waste:
  - moisture content.
  - climatic conditions.
  - degree of compaction.
  - age of the landfill.

- Therefore, the leachate composition cannot be generalised and an **unique treatment option cannot be suggested.**

Leachate

- Although leachate composition varies from one to the other, what they have in common is **hazardous constituents** and their **potential ecotoxicological effects** on human and on terrestrial ecosystems.
- The main leachate **components** are:
  - Dissolved Organic Compounds.
  - Inorganic components.
  - Heavy Metals.
  - Xenobiotic organic compounds.



Leachate

General leachate composition with respect to leachate age (Source: Stegmann et al., 2005)

Parameter	Acid phase (younger)	Methanogenic phase (older)
pH	6.2-7.8	7.0-8.3
BOD_5 (mg/L)	600-27,000	20-700
COD (mg/L)	950-40,000	460-8,300
TOC (mg/L)	350-12,000	150-1,600
NH_4-N(mg/L)	17-1,650	17-1,650
TKN	250-2,000	250-2,000
SO_4 (mg/L)	35-925	25-2,500
Total P (mg/L)	0.3-54	0.3-54
Na (mg/L)	1-6,800	1-6,800
K (mg/L)	170-1,750	170-1,750
Mg (mg/L)	30-600	25-300
Ca (mg/L)	80-2,300	50-1,100
Fe (mg/L)	3-500	4-125
Zn (mg/L)	0.05-16	0.09-3.5
Cr (mg/L)	0.002-0.52	0.002-0.52
Cl^-(mg/L)	315-12,400	315-12,400
Ni (mg/L)	0.01-1	0.01-1
Cu (mg/L)	0.005-0.56	0.005-0.56
As (mg/L)	0.0053-0.11	0.0053-0.11
Hg (mg/L)	0.00002-0.025	0.00002-0.025
Pb (mg/L)	0.008-0.4	0.008-0.4
Cd (mg/L)	0.0007-0.525	0.0007-0.525

Leachate

- In the absence of treatment, leachate is:
  - Recycled back to the waste to maintain the biological activity in the composting solid waste by keeping it moist.
  - Send it to sewer or to a wastewater treatment plant (WWTP) in case they do not treat it on site.

Leachate treatment processes comparative costs (Source: Adapted from Giraldo, 2001)

Treatment technology	Cost (€/m^3)
Aerobic process with nitrogen removing	15.00
Two steps reverse osmosis	7.50
Biologic process + carbon activated + precipitation	18.75-26.25
Biologic process + reverse osmosis + concentrate evaporation	26.25-30.00
LIFE LEACHLESS technology (solar evaporation/condensation + forward osmosis)	**4.75**

LIFE LEACHLESS Project

- LIFE LEACHLESS project demonstrates the **feasibility of an innovative in-situ treatment process** for leachates generated in landfills and waste treatment plants.
- The project LIFE LEACHLESS proposes a **sustainable management** composed of specially designed solar panels, which reach to very high temperatures to evaporate the leachate.
- Then the vapour is condensed to follow its path through **forward osmosis** (FO) step. FO requires less energy than the reverse osmosis (RO) and has less fouling problems.
- The project is **easy to replicate** and **easy to operate** and **maintain**.
- The proposed system is a **universal solution** independent of the leachate composition.

Main objetives

- The LIFE LEACHLESS project will promote water resources management actions in accordance with the **Water Framework Directive 2000/60/EC** by enabling managers of landfills and waste treatment centres to achieve good qualitative and quantitative status of their effluents.

- The LEACHLESS project proposes a **treatment model** that will be carried out **"in-situ"** using a **cost-effective** novel technology that combines **solar evaporation/condensation** plus **forward osmosis**. The prototype will be powered by **renewable energies** (solar energy, biomass and residual heat), which will minimise the **carbon footprint** of the process.

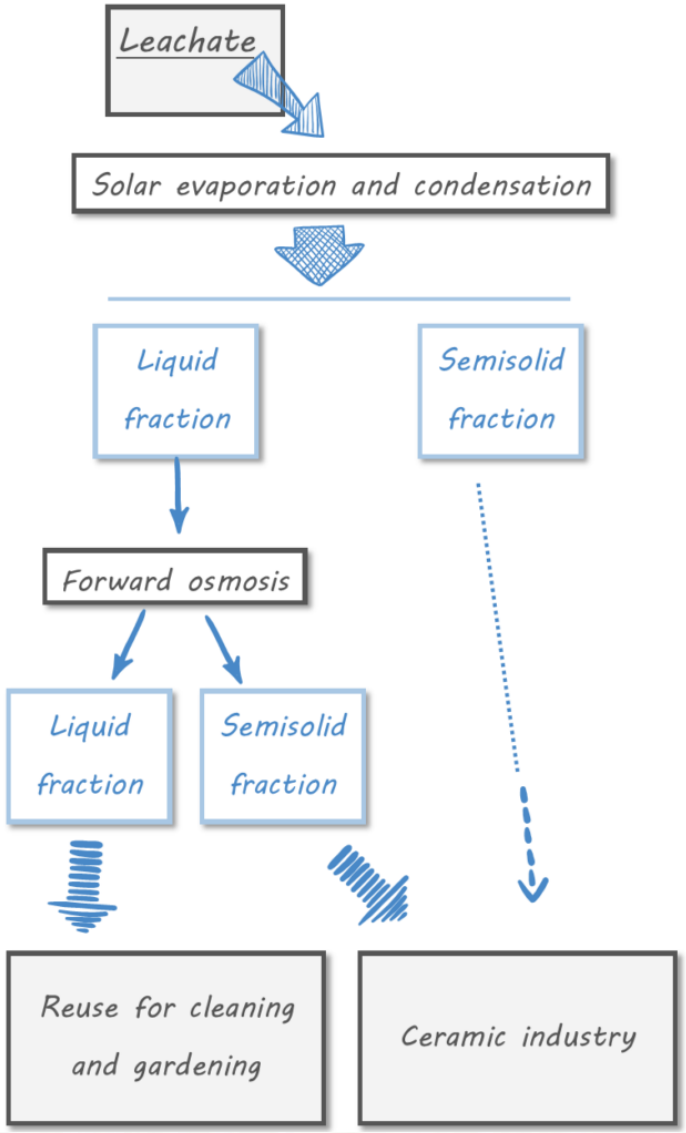
- The final effluents will be **reused** for **cleaning** and **gardening** purposes. A minority **semi-solid** residual **stream** will be also generated in the process. Due to its special composition (rich in metals and inorganic elements), this stream will be **valorised** in ceramic industries to improve the final products characteristics.

The figures of the project

LIFE 15 ENV/ES/00530

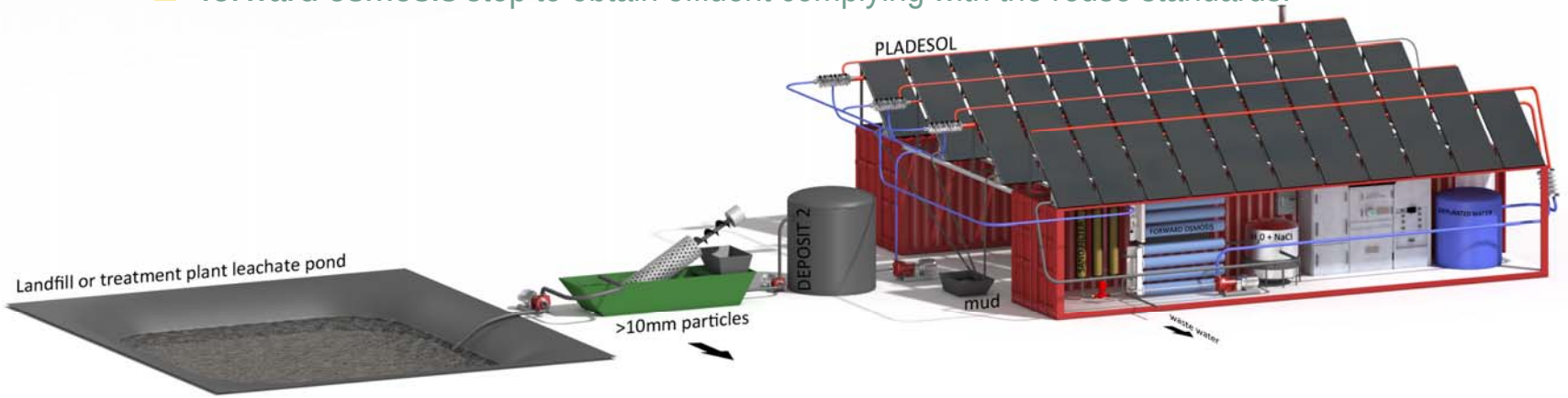
Dates	Start: 01/10/2016	**Figures**	Total budget: 1,775,805 €
	End: 31/12/2019		EU contribution: 1,041,237 € (60% of eligible budget)
	Duration: 39 months		4 partners

Process diagram



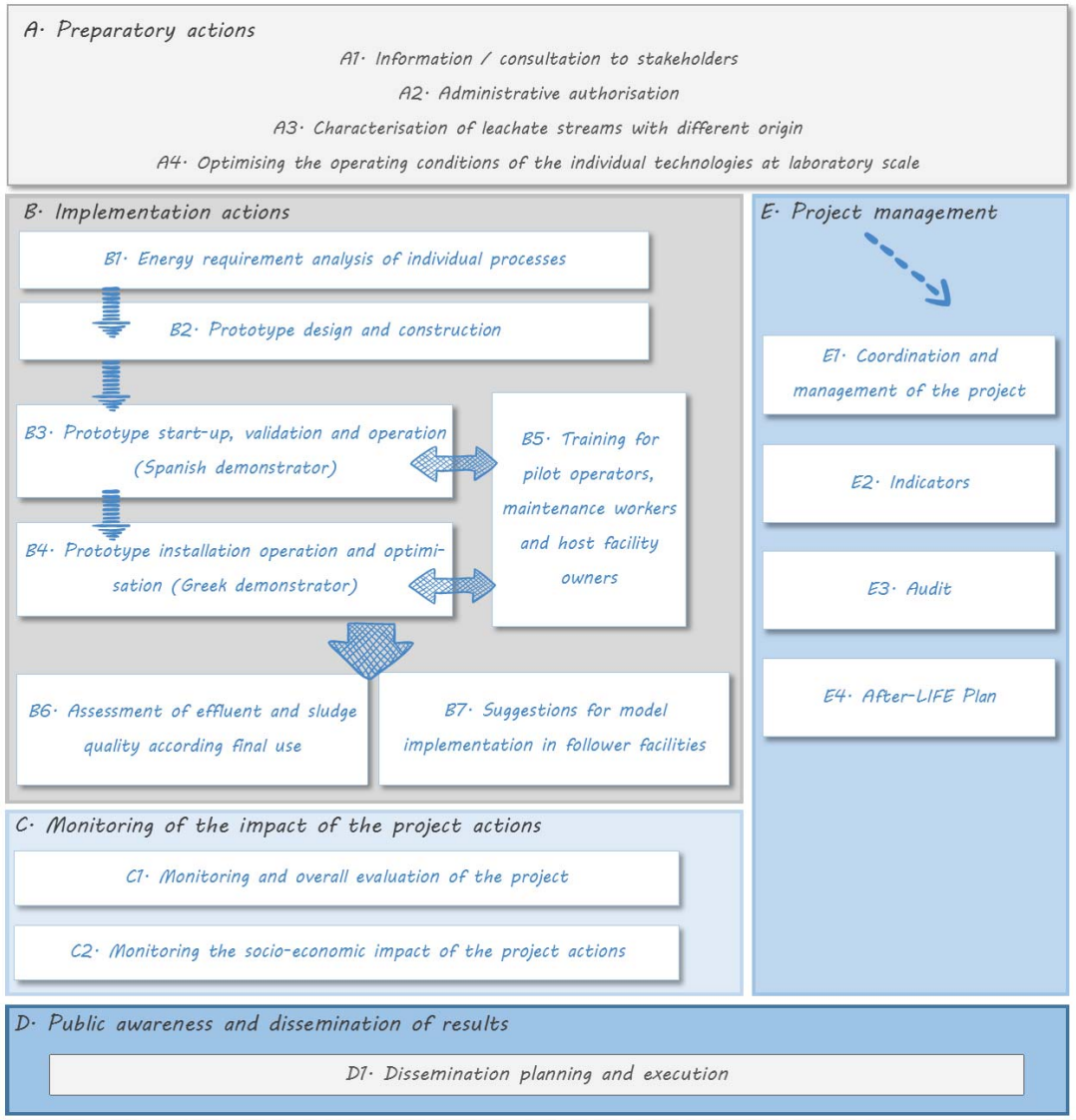
LIFE LEACHLESS Prototype

- The proposed treatment system is composed of two main separation processes:
  - a **novel solar panel**, which evaporates and condenses the leachate in the first step.
  - **forward osmosis** step to obtain effluent complying with the reuse standards.



- This system will be placed in **two containers**, each with dimensions 12mx2.4mx2.9m, for the easy portability between the demonstrations sites:
  - a **waste treatment centre** in Spain.
  - a **landfill** in Greece.
- The maximum **capacity** of the plant is 15 m^3/day.

Pert Diagram



Demo sites

- The first demo site selected is the SECOMSA's Waste Treatment Centre in Catalonia (Spain):

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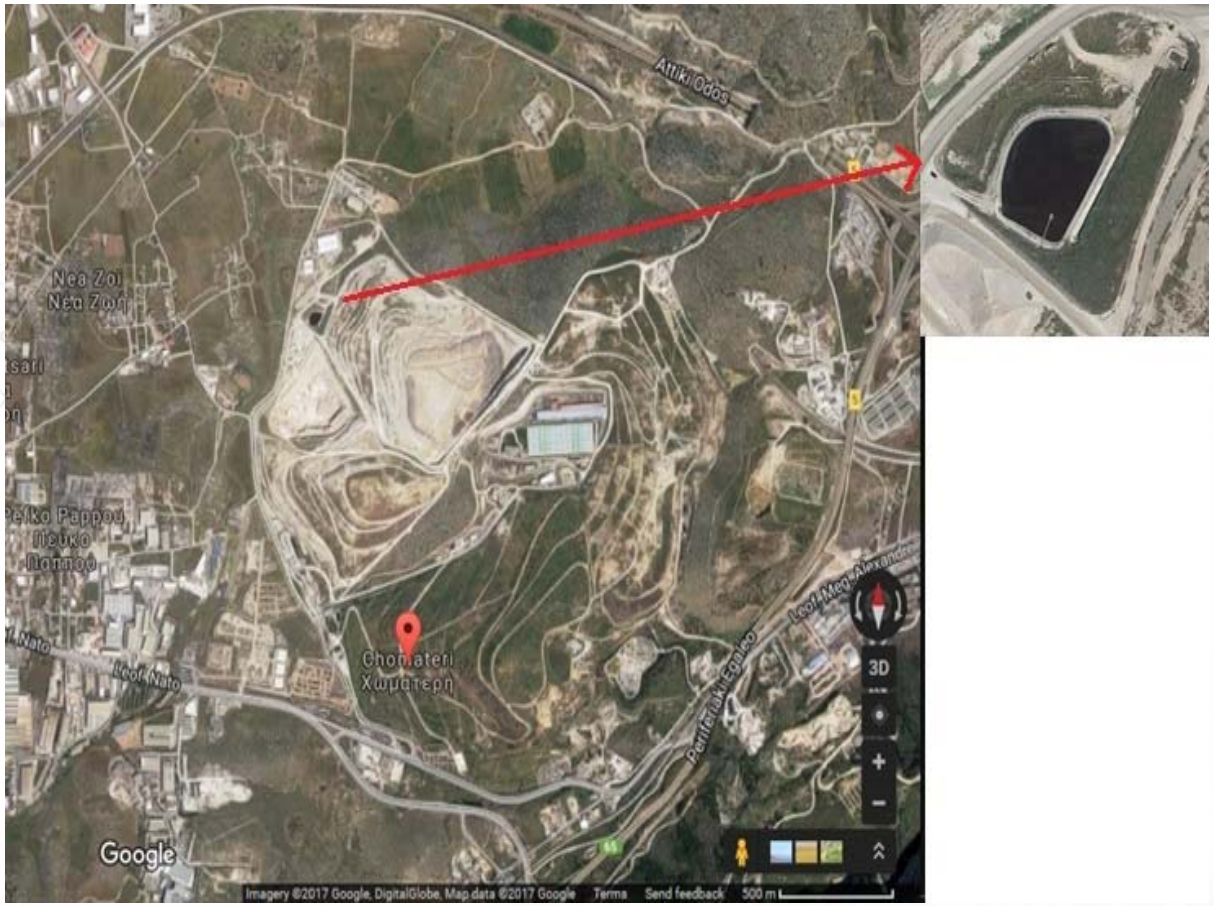
Demo sites

- The second demo site selected is the Ano Liosia landfill in Athens (Greece):



Expected results

- Treatment up to 15 m^3/day of leachate in a prototype introduced in containers for easy transport and installation, that allows flexibility in operating conditions.
- To obtain a high quality final effluent, 100% free of pathogens and xenobiotic compounds that can be reused or discharged into watercourses.
- To reduce the cost of leachate treatment over 80% when comparing with a traditional leachate treatment plant, by using solar radiation, biomass and residual heat as energy sources.
- To reduce by 80 to 90% the environmental impact associated with leachate streams proceeding from waste disposal in landfills or waste treatment centres.
- To **eliminate** the need of leachate **transport** to municipal wastewater treatment plants (WWTPs) and thereby, to eliminate the associated transport costs and the risk of emerging pollutants from leachate entering the overall water circuit and carbon footprint.

Expected results

- To have a **technology applicable** in those European countries (members and candidates) with the highest volume of municipal waste sent to landfill, which are also those, which most leachate generate. These countries (Spain, Greece, Italia, Italy, Portugal, Malta, etc.) are themselves the ones with the higher number of sunlight hours, which favours the operation of such technology.

- Improving the operation of landfills and **reducing** the associated **environmental impact** (contributing to the increased number of landfill adapted to the waste disposal Directive, 1999/31/CE).

- 100% **valorisation** of the by-products generated in the process. The amount of sludge generated as a by-product is very low (1-3% of the total volume of leachate). However, the sludge generated can be valorised since it is interesting for the ceramic industry.

Expected results

- 60% reduction of the leachate storage reservoir size in landfills and waste treatment plants. Pollution removal at the source.
- Dissemination of **good practices**. Creation of a network of contacts for disseminating project results and extending the project scope.
- 2 **replication** studies for transferring the project findings in 2 “follower facilities” (1 in Spain and 1 in Greece) and 1 in Pordenone’s landfill in Italy when the project is completed.
- LIFE LEACHLESS will allow the authorities to **increase** the **competitiveness** and improving environmental legislation by better management of leachate.
- Dissemination of project results at national and international level through the **Dissemination Plan**.

Thank you for your attention

If you have any question, do not hesitate to contact me

More information:

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